Teacher Education

AIDS FOR THE HIGH-SCHOOL TEACHER OF SCIENCE

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Published Four Times a Year by the Editorial Board
of Illinois State Normal University, Normal, Illinois

MARCH, 1952

Aids for the High-School Teacher of Science

Illinois State Normal University was founded in 1857 as the ninth state teacher-training institution in the United States to develop effective teachers for the public schools. Since many things remain untaught in a four-year program and continued in-service training is necessary, it is hoped that the articles in this publication will aid the teachers in service to do a better job of teaching science.

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TEACHER EDUCATION

Field Service Bulletin of the Illinois State Normal University

Normal, Illinois *March, 1952* *Vol. XIV, No. 3*

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Published four times a year in the months of September, December, March, and June. Entered as second-class matter November 25, 1938, at the post office at Normal, Illinois, under the Act of August 24, 1912.

Printed at the Illinois State Normal University Press, Normal, Illinois

High-School Science Clubs

G. Harlowe Evans*

In these days of great technological advances, accompanied by an acute shortage of scientific personnel, the tendency in the secondary schools unfortunately seems to be to reduce the amount of science and mathematics in the curriculum. This reduction calls for some extra-curricular means of promoting interest in science and of giving students more practical experience in it. A well organized and well sponsored science club may fill this urgent need.

Not many years ago extracurricular organizations were demanded and initiated largely by the students themselves. With the widespread growth of such student organizations, it has been recognized that they may have great value, not only in bringing the students together socially but also in supplementing the students' school courses. Clubs may also serve to so inspire the students and to create so much interest in the subject matter that the students do much better work in related classes. As a result, many administrators have been so eager to get such student clubs started in their schools that they have given teacher time and school time for the meetings. Financial support has also been given by the school to the organization and continuation of these clubs. Some educators recommend that every student participate in at least one extracurricular activity.

The participation of a student in departmental club activities is, and should be almost entirely voluntary and unlimited in scope; by contrast, in many cases his classroom participation is required and is restricted in its scope to the subject matter of the day. Thus the club gives freedom and inspires expression; the classroom may represent conformity and repression. In the case of the science club, it may provide opportunity for the member to perform individually conceived experiments that are more complicated and that require more planning and independent study than those customarily given in laboratory manuals. It also gives opportunity for group planning and group participation in relatively extensive projects or related groups of projects. For the student interested in science as a life work, the club may serve to direct him into some useful line of research and give him an early start in it, and for the non-science major it may serve as a desirable source for developing hobbies in later life.

Since a science teacher or someone vitally interested in science is usually asked to sponsor the science club, the student gains by having more intimate and informal contact with an adult scientist. In this way, the student acquires insights and perspectives that he might fail to achieve from more formal classroom work, or by reading alone. Since an effective club sponsor may have more influence on the life and thinking of the student member than any of the other teachers, the careful choice of a sponsor is paramount. Any one who is vitally interested in youth and their development and who is willing

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to spend the time needed in study to advise properly on student projects and meetings, should make a proper sponsor. If he has also had thorough scientific training, he should make a much better sponsor.

There are many questions that may arise in the minds of administrators or science teachers who are interested in starting a science club or in reorganizing or shifting the emphasis of clubs already in being. Among such questions are these: (1) What types of science clubs are there? (2) Who would sponsor the science club? (3) How large need a school be in order to have one or more science clubs? (4) How large may a science club be before it becomes unwieldy? (5) What membership requirements should there be, if any? (6) Where and how often should the club meet? (7) How may it be financed? (8) What should be the nature of its meetings, and who should plan the programs? (9) What types of audio-visual aids may be used at its meetings? (10) In what other types of activities may it engage? (11) With what state and national science organizations may it become affiliated? (12) Where may the sponsor find suggestions for club meetings, projects, exhibits?

To many of these questions there is no adequate answer. The best that can be done is to observe what other successful clubs are doing. In an endeavor to find out what is being done at present in secondary-school science clubs in the state of Illinois, Roger B. Bloomquist, in preparing for his Master's thesis* at Illinois State Normal University, sent 249 questionnaires to high schools in Illinois. Rather than sending to all schools in the state, he chose schools at regular intervals from the *Illinois School Directory* with the expectation that this sampling would be representative. This selection included schools of all sizes in all parts of the state. He received responses from 187 schools, 83 of which had science clubs in operation. Although this is too small a group from which to draw an exact statistical analysis, yet many trends could easily be seen. The remainder of this article is an attempt to answer the previously mentioned questions. His findings are used in part.

The suggested questions will be taken up in order. The first question deals with the types of science clubs. Science clubs may be divided into two major classes: the general type club—the General Science Club, the Chemistry Club, the Biology Club, the Physics Club, and the more specialized clubs—the Radio Club, the Camera Club, the Aviation Club, and Conservation Clubs. In the aforementioned study, it was found that nearly half were general science clubs, about one-fourth were photographic clubs, about an eighth were biology clubs, with chemistry clubs, conservation clubs, physics-chemistry clubs, radio clubs, and visual-aids clubs following in order. This high proportion of general-science clubs is probably due to the fact that in small schools, where only one science club could be supported, only a General Science Club could span the wide diversity of interests. In the larger schools, two or more specialized clubs could operate simultaneously.

The prime requisite in the choice of a sponsor, the second problem

* August, 1951.

to be considered, is vital interest in young people and their problems and development, plus the ability to gain their confidence and respect. It is highly desirable that the sponsor be well and widely trained in science. He need not be one of the science teachers. If his interest and ability are great enough, he might be any other teacher or person of the community; assumably, however, a science teacher would be most logical for the position, if he has the first requisite.

Questionnaires were sent to schools ranging in size from about 50 to 3000 students. The smallest school having a science club had an enrollment of 70, and the largest had about 2000. About 12 per cent of the schools with enrollments below 100 had science clubs; over 26 per cent of those between 100 and 200 had science clubs; and about 50 per cent of those between 200 and 500 in enrollment had science clubs. From these figures it would look as though a school of over 200 that did not have a science club was missing a real opportunity. It would also seem possible to have an effective science club in schools much smaller. In some of the larger schools, two or more science clubs operate.

The size of the science clubs ranged all the way from less than 10 to over 100 members, with the largest number falling between 15 and 30 members. It would seem that, if more than 50 students were vitally interested in a science club, probably two clubs rather than one should be started. It is better to have two relatively small very much interested groups than one that is too large and lethargic. If the groups were not too dissimilar, competition between them in projects and exhibits might serve to stimulate them. Even smaller groups than 50 might well be divided in order to serve special interests, or to promote competition.

Some science clubs are so-called honor societies, restricted to those making the higher grades in all their courses, or at least in science courses. This plan is not generally considered desirable, for those who most need the extra experience do not get it. Other clubs are restricted to those who are currently in some science course. Again this excludes many students who would gain benefit from the club in initiating or furthering a science hobby. It would seem best to open membership, regardless of class affiliation or grades, to those most sincerely interested in the club.

The frequency of club meetings ranges all the way from daily through monthly to irregular meeting times. Biweekly and monthly meetings seem the most popular, with roughly 40 per cent in each category. About 15 per cent meet weekly. Biweekly meetings are highly recommended.

The place of meeting is most often in school classrooms or laboratories. Sometimes a local industry may offer the use of equipment and room space for meetings. In larger centers, museums, libraries, and other civic-minded institutions may offer meeting rooms and other facilities. In the past, club meetings were often held after school or in the evenings. With the increase in the use of school busses, however,

after-school hours have been more and more unpopular. With the increased recognition of the educational value of departmental clubs, many schools are setting aside some school time when all such clubs may meet simultaneously. This plan has the added advantage of preventing students from becoming "joiners" in that they have to choose carefully to which club to give their allegiance.

Since any active science club incurs expense, some means of income must be provided. In the modern-school view, which considers departmental clubs as part of the overall educational privilege of its students, it would seem most logical for the school administration to include their financing, or at least a portion of it, in the regular school budget. Since many administrators do not take care of the financing, many of the clubs have to resort to other means for their financing. Many assess membership dues, ranging all the way from $0.25 to $2.50 for the year, with about 50 percent between $0.50 to $1.00. Some raise money by means of concession stands at athletic events, bake sales, sale of pictures, dances, carnivals, box socials, and school parties. It is highly desirable that the method chosen should have an educational value of its own, that it should give a maximum return for the student time spent, and that it should have public approval. If the public feels that it is being robbed, the method will eventually work to the detriment of the club. Using cheap and unbusinesslike methods in the financing of a club will not only have a cheapening effect on its program, but will hinder its development. A dignified and businesslike approach to its finance will inspire public approval.

The nature of the meetings of the science club should depend largely on the judgment of the members themselves and that of the sponsor. It should probably have rather wide variations in itself in order to cultivate and maintain high interest. Programs of the same type used in meeting after meeting—no matter how desirable in themselves—will probably pall on the members. Outside speakers may be brought in occasionally. Very large clubs, too unwieldy to use the types of meetings mentioned later for smaller clubs, might find themselves limited to certain mass types of entertainment and education, such as outside speakers and/or science movies. For those of small membership, talks by members on special topics, discussion on preparation of group or individual projects, display of collections or exhibits ,demonstrations by members, reviewing of scientific books or articles of special interest, and joint meetings with other clubs will probably be more worth-while and interest provoking than those mentioned earlier.

The sponsor should stand ready to give well timed and helpful advice; but the members, if well guided, will gain more value from planning, taking charge of, and participating in their own meetings. The aforementioned study shows that in practically all of the science clubs the programs for the meetings were planned by the members. In approximately half of the clubs, the sponsor helped in the planning.

The interest in the meetings of the club may be enhanced by the use of various audio-visual aids. Of these aids the study shows

demonstrations, movies, free industrial literature and descriptive pamphlets, specimens and models, slides and film strips to be the most frequently used. Charts and blackboard diagrams are used by some. In localities where there are nearby interesting industries or natural scenic beauties or oddities, an occasional field trip is very helpful. If there are members with a photographic hobby, they might easily be persuaded to make two- by two-inch slides, in either black and white or in color, from life or copies of charts, diagrams, exhibits, or demonstrations, that would be of interest to the whole club. The members would gain valuable experience and at the same time they would be building up a slide library for the club and/or school. In these days an occasional use might be made of television and wire or tape recordings. The making of wire or tape recordings, as well as movies of certain school events would be interesting and valuable experience for those interested in them. Many other audio-visual aids may be available and may be already in use in some clubs.

Much of the preparation of group and individual projects, such as exhibits, models, charts, and notebooks, may go on outside of the regular meetings. The incentive for work on these activities may come from their display at local openhouse meetings and science fairs or from competition among members of the club. Better still is the display of such projects at district and state science fairs sponsored by the Illinois Junior Academy of Science each spring. The stimulation of competition with members of other clubs, in the district or over the whole state, is very helpful. Many very excellent projects are conceived and brought to completion for display as a result of such competition.

Since the system of judging used at these district and state science fairs provides for classification into groups according to quality, every project merits an award. Since there are many first-, second-, and third-place awards, each competitor gains a feeling of achievement, and enthusiasm for further accomplishment is brought back to stimulate the local club. Many of the exhibits and charts prepared may serve later as valuable classroom aids.

The preparation and presentation of a science assembly program for the whole high school may be valuable experience for members of the club. Activities that serve to bring the work of the science club to the attention of the whole school and of the local community are especially desirable. Many local people, if aware of the club, might give valuable assistance in one way or another.

Every science club is urged to become affiliated with the Science Clubs of America. Over 30 percent of the clubs in the study mentioned belong to this national organization. This organization is a part of "Science Service" and furnishes much material and new ideas to the local science clubs and to their sponsors. *The Science Club of America Sponsor Handbook* is full of ideas for the organization and continued operation and stimulation of a science club.

Every Illinois science club is also urged to become affiliated with

the Illinois Junior Academy of Science. Its chief function each year is to sponsor the several district science fairs and a state science fair. At the district fairs, there is no limit put on the number of projects a single club may enter. However, only those receiving first awards in one of the district fairs may exhibit and compete at the State Science Fair. For convenience in judging, the exhibits are divided into the following classifications: Botany, Zoology, General Biology, Chemistry, Physics, Geology, Photography, Weather, Newsletter, Astronomy, Notebooks, Aeronautics, Biology Special Heredity Project and Junior High (seventh, eighth, and ninth grade science). Whether or not a science club has any exhibits to display at these fairs, its members will receive much encouragement and inspiration from attending one or more of them.

Many other affiliations are possible, such as affiliation with local conservation groups and local camera clubs. Any affiliation with other progressive groups should stimulate interest.

Those who are interested in initiating science clubs in their schools and the sponsors entrusted with the day-by-day work of the science club may find valuable assistance in solving their problems by referring to one or more of the following books and articles.

BOOKS

Dale, Edgar. *Audio-Visual Methods in Teaching.* New York: The Dryden Press, 1948.

McKown, Harry C. *Extra-Curricular Activities.* New York: The Macmillan Co., 1950.

Science Clubs of America. *Free and Low Cost Materials for Science Clubs of America.* Washington: Science Service, 1947.

Science Clubs of America. *Sponsor Handbook.* Washington: Science Service 1950.

ARTICLES

"Aiding Young Scientists," *Science News Letter,* LIV (Oct. 16, 1948), 245-246.

Costello, M. S., "Student Activities," *School Science and Mathematics,* XLV (Nov., 1945), 768-769.

Davis, W., "Science Clubs of America—an Educational Force for the Future," *Education,* LXV (March, 1945), 406-408.

Davis, W. "Youth Learns Science," *Science News Letter,* LII (Oct. 4, 1947), 218-219.

Franck, G. P., "Enriched Teaching through Science Club Activities," *School Activities,* XX (May, 1949), 280-281.

Hearn, A. C., "Increasing Interest and Participation in Activities," *School Activities,* XXII (March, 1951), 212-213.

Muroff, J. M., "Activities for a Science Club," *School Activities,* XIII (March, 1942), 254-258.

Patterson, M. E., "Clubwork Makes Science Fun," *Science News Letter,* LVI (Sept. 17, 1949), 186-188.

Platt, H. H., "Science for Fun," *Journal of Chemical Education,* XVI (June, 1939), 265-267.

"Science Clubs Abroad," *Science News Letter,* LVI (Aug. 6, 1949), 85.

Shannon, J. R., "Student Activities and Leadership," *School Activities,* XXII (Feb., 1951), 183.

Thompson, J. W., "How the Junior Academies of Science Operate," *Scientific Monthly,* LXIV (April, 1947), 327-336.

Weigel, R. M., "Organizing the Science Club," *School Activities,* XXII (Jan., 1951), 157-158.

Those interested in affiliating with Science Clubs of America, or in information on the National Science Talent Search and many other science scholarships available to talented senior science students may write to Science Clubs of America, 1719 N. Street, N.W., Washington, D.C. Those interested in affiliating with the Illinois Junior Academy of Science may write to Robert L. Smith, State Chairman, Illinois Junior Academy of Science, DeKalb Township High School, DeKalb, Illinois.

Those interested in sending projects to, or in merely attending the district science fairs may write to the appropriate one of the following:

Chicago Area Illinois Junior Academy District Fair
J. Sterling Morton High School and Junior College, Cicero, Illinois
District Chairmen—George S. Porter and W. L. Meuhl
Counties assigned to this District—Lake, Cook, Dupage, and Will

Northern Area Illinois Junior Academy District Fair
Northern Illinois State Teachers College, DeKalb, Illinois
District Chairman—(Temporary) Robert Smith, DeKalb Township High School, DeKalb, Illinois
Counties assigned to this District—JoDaviess, Stephenson, Winnebago, Boone, McHenry, Carroll, Ogle, Kane, Whiteside, Lee, DeKalb, Kendall, Will, Bureau, LaSalle

Northwestern Area Illinois Junior Academy District Fair
Western Illinois State College, Macomb, Illinois
District Chairman—H. W. Crall
Counties assigned to this District—Rock Island, Mercer, Henry, Stark, Peoria, Knox, Warren, Henderson, Hancock, McDonough, Fulton, Adams, Schuyler, Brown, Cass, Mason, Menard

Central Area Illinois Junior Academy District Fair
Illinois State Normal University, Normal, Illinois
District Chairman—Harold L. DeWeese
Counties assigned to this District—Putnam, Grundy, Kankakee, Marshall, Woodford, Livingston, Iroquois, Tazewell, McLean, Ford, Champaign, Piatt, DeWitt, Macon, Logan

Southwestern Area Illinois Junior Academy District Fair
Blackburn College, Carlinville, Illinois
District Chairman—Gus C. Hinveber
Counties assigned to this District—Pike, Scott, Morgan, Sangamon, Christian, Montgomery, Macoupin, Greene, Jersey, Calhoun, Madison, Bond, Clinton, Fayette, St. Clair

Southeastern Area Illinois Junior Academy District Fair
Eastern Illinois State College, Charleston, Illinois
District Chairman—A. J. Hoffman
Counties assigned to this District—Vermilion, Edgar, Douglas, Moultrie, Shelby, Coles, Cumberland, Clark, Effingham, Jasper, Crawford, Clay, Richland, Lawrence, Wabash, Edwards

Southern Area Illinois Junior Academy District Fair
Southern Illinois University, Carbondale, Illinois
District Chairmen—Dr. Clyde Brown, Southern Illinois University
Miss Esther Smith, Murphysboro High School
Counties assigned to this District—Monroe, Randolph, Washington, Perry, Marion, Jefferson, Wayne, White, Hamilton, Franklin, Jackson, Williamson, Saline, Gallatin, Hardin, Pope, Johnson, Union, Alexander, Pulaski

Most of these fairs are to be held on April 19, 1952. The State Science Fair is to be held at Charleston on May 2-3, 1952.

Safety in the High-School Chemistry Laboratory*

When the chemistry laboratory performs its true educational function, it is the most effective means available for teaching chemistry. Learning the significant and fundamental facts of chemistry, the development of desirable habits and attitudes, and the mastery of the scientific method are important educational values that are best obtained in the chemistry laboratory. Although all of these values are usually related to developing the mind of the student, to help develop the mind without teaching the means of preserving the body is a rather lopsided view of education. All education may be lost completely if adequate instruction in safety is not given the student. As a means of preventing this loss it is essential that safety education become an integral part of the chemistry laboratory work.

The average group of students in a high-school chemistry class are inexperienced, are prone to carelessness, and often may be irresponsible. Such a group, without proper safety instruction, would have many accidents throughout the course. However, accidents are not a normal or essential part of chemical operations; therefore, with proper safety instruction they can be prevented. The purpose of this paper is to acquaint students and teachers with their responsibilities in preventing accidents, and, also, with their responsibilities in case an accident does occur. Lack of knowledge of these responsibilities has caused accident after accident in the high-school chemistry laboratories.

Although industries recognized the need for safety education as early as 1904, when the first law was passed governing industrial safety, the schools have only recently acknowledged this need. The departments of industrial arts and physical education have been the leaders of the safety movement in the high schools. Many studies have been made on the number and types of accidents in these fields. Chemistry teachers have been much slower in developing adequate safety programs and maintaining proper records of accidents in their classes; therefore, studies concerning safety in the chemistry laboratories are very much limited. Some material that is related to safety in high-school laboratories may be obtained from studies made by scientific supply companies or industries that have large chemical laboratories. The Fisher Scientific Company is one of the leading agencies for promoting safety in the chemistry laboratory.

Two terms used throughout this paper should be clearly defined. They are *safety* and *accident*.

The National Safety Council defines *safety* as follows:

> Safety is not a subject for separate class-work. It is a point of view which may be developed in many different ways until it becomes a state

*The information in this article is based upon the work done by Kenneth Curry for a Master's thesis, submitted in August, 1951, in partial fulfillment of the Master's degree.

> of mind. It cannot be pigeonholed by itself. If this is attempted, it loses its natural relationships and its proper place in the scheme of things. . . . But safety involves certain concrete skills, knowledges, habits, and practices as well as a point of view. It is of the first importance that the child should have the opportunity actually to live through experiences that will develop these objectives.[1]

Throughout this paper safety has been used according to this definition.

There are two fundamentally opposed definitions of the word *accident*. One holds that an *accident* is the hand of Fate reaching out to govern the course of human events. The other holds that human beings can govern their own acts and thus avoid accidents. Although each of these views has its own adherents, it is probable that many people accept both philosophies, applying whichever seems the more appropriate in a given instance.[2] This paper is written with the belief that accidents can be prevented and that, when they occur, it is the fault of some human act, not the act of Fate.

THE TEACHER'S RESPONSIBILITY FOR SAFETY

The chemistry instructor is the teacher, the supervisor, and the example of safety in his laboratory. The safety education of the students is as much the responsibility of the teacher as is their chemical education.[3] A knowledge of the hazards attending the handling and use of dangerous chemicals and equipment is a necessary part of technical equipment of the science teacher and science supervisor. However, a knowledge of the problems and techniques for teaching safety is not enough. As in other fields, the teacher must really understand and believe in the work. Without conviction and enthusiasm here, results are likely to be meager.[4]

Legal Aspects of Safety Education

"Accident due to carelessness on the part of the student" frequently is the alibi that teachers give for accidents that occur in their chemical laboratories. This statement is as highly unscientific as it is inadequate. If it is proper to assume that every accident has a cause and did not just happen, then someone or something is to blame. It may be found in some instances that, although the apparent cause of the accident was "carelessness on the part of the student," the basic responsibility rests with the instructor or even with the school administration because of failure to provide proper equipment, supervision, or instruction.[5]

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[1]National Safety Council, Education Section, *An Introduction to Safety Education* (Chicago: National Safety Council, Inc., 1924), p. 13.

[2]Robert W. Eaves and Stanley A. Abercrombie, "Complete Concepts of Accident," *The Journal of Educational Sociology*, XX (Oct. 1946), p. 85.

[3]John S. Shaw, "Is the School Laboratory a Frankenstein?" *Journal of Chemical Education*, XXI (Nov., 1944), p. 541.

[4]Edgar Fuller, "Everybody's Responsibility," *Safety Education*, XXX (Oct., 1950), p. 33.

[5]Paul L. Cressman and others, *Industrial Safety Education in Schools*, Metropolitan Life Insurance Company School Health Monograph Number 1 (New York: Metropolitan Life Insurance Company), p. 10.

Throughout most of the United States (Illinois included) the common-law principle prevails that a school district or a school board is not, in the absence of specific permissive legislation, subject to liability for injuries suffered by pupils or others during and in their attendance at school.[6] However, both the teacher and the school district are responsible for providing and maintaining a safe working situation into which the pupil can fit himself. The safe working situation includes safe equipment and adequate instruction to every pupil.[7] Providing a safe working situation is primarily the responsibility of the teacher.

Where it can be shown that there has been negligence in providing a safe working situation, the teacher can be held legally responsible. Negligence is the failure to act as a reasonably prudent and careful person would under the circumstances involved. The teacher must act toward the pupil as would a reasonably careful and prudent parent. If a reasonably prudent person should anticipate danger, then failure to take the necessary precautionary steps constitutes negligence.[8]

When working conditions are safe for the class as a whole, they are safe for every individual, but, although the class as a whole has been given safety instruction, it does not necessarily mean that every pupil has had sufficient safety instruction. That the teacher's word alone is not sufficient to establish the fact that adequate safety instruction has been given is evidenced by the fact that in many of the cases where decisions have been against the teacher, the injured pupil has denied ever having received safety instruction.[9] A court trial may be prevented if a careful report of the accident is made immediately after it happens.

Both the teacher and the administrator should be aware of their liability. Few are adequately informed as to the extent and nature of their responsibilities.[10] The administrator of the school often does not understand the hazards connected with the chemistry laboratory. It is the responsibility of the teacher to make the administrator aware of these hazards. The administrator, then, has the responsibility of following the teacher's suggestions to reduce these hazards. An example of the way this joint responsibility should work is shown in the case of the chemistry teacher's being called from the laboratory while the class is in session. If a teacher is requested by a superior officer to leave the room, the responsibility of the class is placed with the person issuing the request, but the teacher should make this condition clear to the superior officer in case the latter is not aware of the

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[6]Victor L. Jepson, "School Liability and the California Courts," *American School Board Journal*, CXIII (Oct., 1946), p. 37.

[7]Jesse E. Rathbun, "Moral and Legal Aspects of Safety Education," *Industrial Arts and Vocational Education*, XXXV (Nov., 1946), p. 369.

[8]Jepson, *op. cit.*, p. 37.

[9]Rathburn, *op. cit.*, p. 379.

[10]Jepson, *op. cit.*, p. 38.

danger. If it should prove absolutely necessary for a teacher to leave the room, the administrator should place another teacher or employee paid by the board of education (not a student) in charge of the class.[11]

Many teachers feel secure because there are printed rules and regulations posted in the laboratory, to which reference can be made by the students. Thorough instruction and printed rules do not meet the legal problems of safety in the laboratory. To be sure, they make up a very important part of any safety program, but, unless there is proof immediately available at all times that every individual understands them, the program is not complete from a legal point of view.[12] It is the responsibility of the teacher to use methods of emphasizing safety so that each of the students is fully aware of all the hazards of the chemistry laboratory.

Methods of Emphasizing Safety

Sidney Birnbach[13] made a comparative study between accident repeaters and accident-free pupils. These groups were given the National Safety Education Test, which revealed that the accident-free group had a more comprehensive knowledge of safety than the repeaters. No pupil in the accident-free group failed in this test, whereas 41.9 per cent of the repeaters failed. The scores from the free group ranged from a low of 54 to a high of 72, whereas the repeaters' scores ranged from 30 to 68. The maximum possible score was 80. No other factor studied in this research showed such a significant difference between accident repeaters and accident-free pupils as did the factor of safety knowledge.

There are some other factors that Birnbach studied that are worthwhile to emphasize. When these same groups were given the Bell Adjustment Inventory, the scores showed a larger percentage of maladjustment, especially emotional maladjustment, among the accident-repeater group than among the accident-free group. An examination of intelligence ratings showed no significant difference between the intelligence rating of the accident-free pupils and the accident repeaters. An examination of classroom teachers' evaluation of pupil growth in personal and social relationships showed that accident-free pupils were rated higher on industry, dependability, courtesy, and cooperation than were the repeater group.

Although this study was concerned with all types of accidents, it shows that, if the teaching of chemical safety is to be effective, it must be based on facts. Chemical safety is built upon two solid rocks: an understanding of the laws of chemistry and physics that govern

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[11]Michigan State Board of Control for Vocational Education, *Training for Safety*, Bulletin No. 279 (Lansing, Michigan: State Printing Office, 1942), p. 12.

[12]Rathbun, *op. cit.*, p. 379.

[13]Sidney Birnbach, *A Comparative Study of Accident-Repeater and Accident-Free Pupils*, Research Contributions to Safety Education, Center for Safety Education (New York: New York University, 1948).

the elements and their compounds, and a thorough planning for all the possibilities that may result from their chemical and physical behavior or misbehavior. Young people just beginning their study of chemistry cannot be expected to have a thorough knowledge of chemical behavior. That knowledge comes from years of experience.[14]

In order for the laboratory to be safe, the teacher must have a knowledge of chemical safety and be able to transmit it to the pupils in such a way so that they will realize that safety is an individual and cooperative responsibility.

> Continuous publicity is essential to the success of any accident-prevention campaign. Because the ultimate control of accidents lies within the power of the individual exposed to the hazards, the student needs to be constantly reminded of safety in order that the right habits of thought and action shall be formed.[15]

> Industry has found that modern commercial advertising is one of the most valuable means of creating an individual desire for a given commodity or of arousing interest in a given subject. It has been found equally effective when applied to the prevention of accidents, as a means of reaching the working force frequently with a direct message.[16]

In industry, the usual methods of publicizing safety consist of posters and other bulletin-board displays, safety messages or slogans drawn on blackboards, safety signs, house-organ articles, and pay-roll slips.[17] Although industry has improved its safety record nearly every year with these methods, they are not sufficient for the high-school student. Most of these methods give a rule or some other type of restraint that must be followed. One of the characteristics of adolescence is the desire for adventure and the accompanying distaste for restraint. Many persons fallaciously look upon safety as negative, as taking something out of life. This concept is widespread among adolescent youth.[18] Safety does not rob life of adventure but only substitutes a worthy adventure for a harmful adventure. Safety is not something negative; the teaching and practice of safety do not impoverish a student's life; they enrich it.[19]

Instead of stressing rules and regulations, the teacher should deal with concepts such as efficiency, enjoyment, and economy. There should be more effort to bring the social concept into the program on accident prevention so that young people will see that what affects one person is certain to affect others. Safety should widen experience and extend enjoyment to students. Getting such concepts across re-

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[14]Shaw, *op. cit.*, p. 539.

[15]Metropolitan Life Insurance Company, Safety Bureau, *Industrial Safety* (New York: Metropolitan Life Insurance Company), p. 51.

[16]Idabelle Stevenson, *Safety Education* (New York: A. S. Barnes and Company, 1931), p. 84.

[17]Metropolitan Life Insurance Company, Safety Bureau, *op. cit.*, p. 51.

[18]American Association of School Administrators, Safety Education, *Eighteenth Yearbook* (Washington: National Education Association, 1940), p. 103.

[19]George H. Payne, *Education in Accident Prevention* (New York: Lyons and Carnahan, 1919), pp. 148-49.

quires the best of teaching.[20] The use of demonstration, visual aids, publicity of accidents, and talks from safety directors in industry all will aid in getting these concepts across. The teacher must remember that safety is not something to be memorized; it is something to be lived. It is not alone a matter of giving information about some hazard; it is a larger problem of developing actual skills and practices and encouraging proper attitudes.[21] A student may know that he is not to pour water into acid, but his actual practice is what counts.

Survey of Laboratories for Unsafe Conditions

To anticipate an accident and to prevent it before it happens indicate safety. This is the teacher's greatest responsibility in promoting safety in the chemistry laboratory. The alert teacher who makes periodic surveys of his laboratory to determine any unsafe conditions will do much to reduce the number of accidents by his anticipation of them. There is much the teacher can do to correct unsafe conditions, but there are also many things that will require the support of the school administration and school board to correct. A recommendation for the elimination of these unsafe conditions should be submitted in a formal report to those in authority and followed up until the condition is corrected.

The proper storage and the labeling of chemicals are requirements of safety which the teacher can easily fulfill with a little work. John S. Shaw[22] in his article, "Is the School Laboratory a Frankenstein?" has listed five precautions to be observed in the storing of chemicals. These precautions are:

1. Store all bottles so labels are prominently displayed.
2. Mark poison bottles and keep stored separately.
3. Take particular care with chemicals that need special storage.[23]
4. Provide ample space between bottles so that students can grasp them firmly.
5. Dispose of their contents if bottles are unlabeled.

If these five precautions were strictly adhered to, they would reduce the number of accidents in the chemistry laboratories considerably. There are many other precautions that should be followed in the storing of chemicals and equipment. Some of these are taken for granted by many science teachers. For instance, it is taken for granted that the usual common-sense rules of storage should be painstakingly followed even in the case of apparatus and supply stocks that in themselves are harmless.[24]

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[20]Fuller, *op. cit.*, p. 33.

[21]Herbert J. Stack, "Greater Safety for Our Youth—an American Opportunity," *The Journal of Educational Sociology*, XX (Oct., 1946), p. 119.

[22]*Op. cit.*, p. 542.

[23]For care of specific chemicals see "Storing Common Hazardous Chemicals."

[24]Fisher Scientific Company, *Manual of Laboratory Safety* (Pittsburgh: Fisher Scientific Company, 1950), p. 3.

The majority of chemical laboratories store chemicals in alphabetical order. This method is the easiest, but hardly the safest. The safest method of storing chemicals requires careful planning on the part of the teacher. The following suggestions are given to aid the teacher in this planning:

1. Especial care in the grouping of liquid reagents to circumvent the dangers of hazardous combinations or heat should be pre-planned. Chemicals that might react together to produce dangerous fumes, fire, or explosion demand storage place remote from one another.[25]
2. Chemicals that have poisonous vapors should be stored in ventilated hoods or in other places where there is ventilation with outside air.
3. All inflammable, explosive, poisonous, or otherwise dangerous chemicals should be stored separately under lock and key, and access to them should be had only by a limited number of thoroughly informed and responsible persons.[26]
4. Generally, heavy items should be stored on or as near the floor as possible; apparatus and glass tubing should not project beyond front shelf limits.[27]
5. Bottles of liquid should never be stored in window sills where sunlight may shine through them; they act as lenses and can focus the sun and thus cause fires.

Many teachers have to work in situations where facilities for having a safe laboratory are decidedly lacking. The alert, patient teacher can do much to bring about a program of improvement by bringing the needs of his class to the attention of the proper authorities. If funds are not available, other means can be found. Interested parents and parent groups frequently come to the aid of the teacher if they are made conscious of the needs of the children while at school. In this regard, teachers should work cooperatively and not despair if results do not always come quickly. They should bear in mind that continuous effort will eventually bring results.[28]

Proper ventilation is one important consideration that is often lacking in the high-school chemistry laboratory. To insure proper ventilation, the school must expend a considerable amount of money. Therefore, the teacher should point out that proper ventilation is an important consideration, since general comfort as well as control of toxicity and inflammability depends to a considerable extent on proper balance of air flow. Ventilation experts attached to state health

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[25]*Ibid.*

[26]Central Scientific Company, *Laboratory and Demonstration Equipment for Secondary-School Chemistry and Precautions To Be Observed in the Handling and Use of Chemicals* (Chicago: Central Scientific Company, 1948), p. 21.

[27]Fisher Scientific Company, *op. cit.*, p. 4.

[28]Herbert J. Stack and Elmer B. Siebrecht, *Education for Safe Living* (New York: Prentice Hall, Inc., 1946), p. 113.

groups are frequently helpful in such problems.[29] A well-ventilated laboratory hood is a fundamentally essential feature of every properly ventilated chemical laboratory. The laboratories of educational institutions should include a sufficient number of such hoods to provide for all students, in squads, if necessary.[30]

Other improvements which the teacher should seek cooperation in obtaining are discussed later. Proper shelving should be constructed. Large shelving for storage of equipment and chemicals as well as small side shelving for chemicals that are used daily is necessary. All shelving should have a coping to prevent objects from sliding or rolling off the shelf. A metal cabinet with a lock and key should be obtained to store chemicals that are dangerous. A shut-off valve for all gas outlets should be located in the laboratory and in such a position where the teacher can easily reach it. Every laboratory room should have two exits; in addition to the main door, there should be a secondary escape hatch in the side walls, or some other arrangement so that an occupant may leave the room quickly in case fire or other emergency blocks his route to the main door.[31] Special emergency equipment that should be obtained is discussed later.

Instruction in the Use of Chemicals and Equipment

An important responsibility of education is to promote to the optimum the student's ability to plan and direct his own life. In connection with this responsibility, the use of intelligence is, of course, central. Cultivation of self-direction does not mean that the student is to be free to do as he pleases, but rather that he is to be helped to attain intellectual independence through the exercise of intelligence in what he does from day to day.[32]

The safe use of materials from day to day is a necessity for the student to obtain his intellectual independence. Therefore, "adequate instruction in the correct use of hazardous equipment and materials is a **must** in the science laboratory. Continuous supervision is essential while dangerous equipment is in use."[33] The teacher's responsibility is not only to give proper instruction on the use of dangerous materials but to develop intelligent constructive actions to replace the impulsive, curious actions which most youth have in regard to chemistry.

There is hardly a chemistry student who at one time has not shown a curiosity toward explosives. To many, this curiosity has proved fatal.

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[29]H. H. Fawcett, "Laboratory Safety," *Chemical and Engineering News,* XXIX (April 2, 1951), p. 1304.

[30]Central Scientific Company, *op. cit.,* p. 21.

[31]Fawcett, *op. cit.,* p. 1304.

[32]Progressive Education Association, Commission on Secondary-School Curriculum, *Science in General Education* (New York: D. Appleton-Century Co., 1937), p. 51.

[33]American Association of Teachers Colleges and National Commission on Safety Education, *Safety Education for Teachers* (Washington: National Education Association, 1946), p. 46.

> One brilliant high school senior became so impressed with explosives in the chemistry class that he accumulated 15 laboratory manuals and converted his basement into a research laboratory. Two classmates served as his assistants in the experiments which for months shook the neighborhood vacant lots and resulted in repeated protest from residents and the police. One Saturday morning the research trio had concocted a new mixture and placed it in a crude bomb made from a short length of pipe capped at both ends. The mixture detonated by friction from the threads of one cap. One of the three lost so much blood from wounds that he died a few hours after reaching the hospital; the second died a few hours later from a piece of pipe which had punctured his liver; the third was so disfigured about the face and neck that months of painful plastic surgery were required before his face again appeared human.[34]

All too often such curiosity toward explosives causes similar results, and often it is the teacher who first arouses this curiosity. Many beginning teachers believe that a unit on explosives is necessary to insure interest in the class, when actually they should minimize the discussion of explosives. "The young chemist's attention should be diverted to other experiments which are of a less dangerous nature. Youth must learn that society looks to science for constructive work."[35]

Many youths would not be able to obtain chemicals to make explosive mixtures if they were not able to obtain them from the high-school laboratory. The teacher cannot over-emphasize dangers involved in removing chemicals from the laboratory.

> Students who wanted to make a bomb stole chemicals from the high-school storeroom conveniently left with a key in its lock. They mixed potassium chlorate, red phosphorus, and powdered charcoal in a battery jar. The 18-year-old student holding the jar lost both hands when the mixture blew to pieces.
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> Five teen-agers stole pieces of metallic sodium from the chemistry storeroom and placed them in the drain of a drinking fountain. When another student started to drink from the fountain, the metal reacted violently with the water, causing an explosion that showered the face of the innocent victim with fire and lye.[36]

These accidents and many similar ones are the fault of the teacher as much as they are that of the students who cause them. The teacher should not merely emphasize the dangers in removing chemicals from the laboratory, but he should take every possible step to insure that they are not removed. No one should be allowed in the laboratory when the instructor is not there, and laboratories should be kept locked at all times when not in use in order to prevent any student or unauthorized person from conducting unsupervised experiments or taking chemicals for outside use.[37]

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[34]H. H. Fawcett, "Misdirected Curiosity Produces Fatal Results," *Journal of Chemical Education,* XXIV (Sept., 1947), p. 457.

[35]*Ibid.*

[36]*Ibid.*

[37]National Safety Council, *Chemicals, Safety Education Data Sheet Number 14* (Chicago: National Safety Council, 1946), p. 3.

The importance of following directions in mixing chemicals or in doing an experiment should be stressed continuously by the teacher. Before each new experiment, the teacher should carefully read over the instructions to be sure that all necessary safety precautions have been mentioned. Students should be taught to realize the possible dangers of careless mixing and to follow directions implicitly. When an experiment with particularly hazardous possibilities is being done in class, it is wise for the teacher to supervise students closely.[38]

The need for close supervision was recently brought out in an accident that occurred with an experiment on white phosphorus. While studying the properties of phosphorus, each student was to burn a small piece in the open. The instructor gave all the students definite instructions on how to do this. One student placed the white phosphorus in a flask and started to heat it, and an explosion followed. The boy carrying out the experiment nearly lost the sight of both eyes and six other students received such severe cuts that they required a doctor's care. At the time of the accident, the teacher was at his desk correcting papers.[39]

Students should be provided with proper equipment and should be taught how to use it. The following list contains specific instructions on how to do safely definite tasks that are required in nearly all high-school chemistry laboratories:

1. Pupils, in the laboratory work involving the heating of chemicals in tests tubes, should be cautioned against looking down into the tube while heating it, or pointing the mouth of the tube in the direction of any other pupil during the process.
2. Pupils should be given instructions on heating liquids in soft glass test tubes to avoid possible injury. The tube will probably break if it is not thoroughly dry on the outside, or if the flame is concentrated at one spot for any length of time.
3. Pupils, when heating liquids in test tubes, should be instructed to heat from the upper portions of the tube downward. Otherwise, vapor meeting a head of liquid above it may cause the bottom of the tube to be blown out.
4. Pupils should be taught to recognize when a Bunsen burner "strikes back," and should be warned to shut off the gas immediately and not to touch the barrel of the burner. Pupils should be cautioned about possible danger of their sleeves' catching fire when they are using the Bunsen burner.
5. Pupils should be informed that in any experiment wherein a gas is collected by water displacement, the delivery tube should be removed from the generating end flask or tube when they are finished with the experiment, to prevent water from being forced back into the hot generator. When a thistle tube is

[38] *Ibid.*, p. 2.
[39] *The Peoria Journal*, April 17, 1951, Sec. B, p. 1.

employed in adding acid, pupils should be told to make certain that the delivery tube is not clogged, or the pressure developed will force the acid up through the thistle tube and possibly splatter it.

6. Many a burned hand might be prevented when a glass tube is heated for bending, if the student is taught to hold the hot tube with tongs close to, but not touching his free hand and test its heat by blowing across the tube against his hand to see whether the tube warms his breath.
7. An amateur testing for ammonia or other similar odorous chemicals often draws in a good whiff of an unknown compound. If the tester were taught to waft a little of the air above the chemical toward his nose with one hand and smell an air-diluted vapor, he would save himself a deep draught of possible poisonous gas.
8. Students should be taught to fill pipettes by using a suction pump or aspirating tube, never by sucking the pipette with the mouth; a student is likely to draw some toxic or corrosive chemical into his mouth by accident and poison or burn himself badly.
9. Improper insertion of glass tubing into rubber stoppers causes many accidents. Here are the steps necessary for proper insertion. First, fire polish the glass tubing. Ascertain whether or not the hole in the stopper is large enough to accommodate the glass. Moisten the tube and the stopper thoroughly. Hold stopper between thumb and forefinger, not in the palm of the hand. Grasp tube close to the end that is to fit in the stopper and twist it in with a slight rotary motion. Have the tube protrude all the way through the stopper, so that the hole cannot close when the stopper is heated or attacked by solvents or other chemicals.
10. Students, when pouring a liquid from a bottle, should be instructed to grasp the bottle so that the label is in the palm of the hand. If this is done, the drop that runs down the bottle will not come in contact with the hand or ruin the label. The stopper should be held between the knuckles of the hand holding the bottle. This avoids contamination of the stopper or possible damage to the pourer or the desk. Drops of chemicals remaining on the bottle should be washed off.
11. All volatile, flammable liquids should be distilled under exhaust hoods. Chemicals giving off poisonous vapors or dust should be handled under hoods to avoid inhaling vapors. It must be remembered that some poisonous vapors have no odor.
12. Students should be given instructions on how to dilute acids. Never add water to concentrated acid. If it is necessary to prepare diluted acid, the concentrated acid should always be added in small quantities to the water, stirring all the while. Hydrochloric acid should be used instead of sulfuric acid in

all probable cases. The volatility of the former makes it less harmful to clothing and skin. In addition, it is less corrosive.

The first five precautions were taken from a pamphlet entitled *For Greater Safety in Science Teaching*[40] published by the Board of Education of New York City. The remaining seven precautions are taken from John S. Shaw's article, "Is the School Laboratory a Frankenstein?"[41]

Good technique in assembling apparatus correctly, handling materials properly, and proceeding methodically should be practiced in demonstrations carried out by the teacher. The teacher sets the example for the students. Teachers should perform classroom demonstrations only if they themselves have previously tried them out. During the demonstrations, the teacher should observe all possible precautions to prevent damage to the students, the equipment, or to himself.

Use of Emergency Equipment in Case of Fire

Despite precautions taken to prevent fires and injuries in laboratories, these mishaps do occur as the result of unforeseen circumstances or as a result of the fact that the careless worker exceeds the bounds of allowable risks. Consequently, knowledge of both firefighting and first aid is highly desirable.[42] It is the chemistry teacher's responsibility to have a thorough knowledge of these matters and to instruct his students in the fundamentals of them so that damage to the students, the building, and equipment will be minimized in case of an accident.

"Explosions and fires are two real dangers in a chemical laboratory. An explosion is over almost before it begins, but it is apt to result in a fire."[43] Sitting around almost every laboratory are enough flammable solvents to produce a holocaust. However, the younger chemist, especially the high-school student, does not always appreciate the potential fire hazards of the materials with which he is working.[44] Therefore, firefighting equipment is a very necessary part of any chemistry laboratory and knowledge of its use is essential.

There are several methods of reducing or eliminating fatalities and damage in school fires. Some of them are: (1) preventing school fires, (2) putting out fires automatically and immediately, and (3) taking the pupils away from the fire hazard.[45] The majority of the fires that originate in the chemistry laboratories could be prevented if the responsibilities of the teacher were fully and conscientiously observed.

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[40]New York: New York City Board of Education, 1949. p. 7.
[41]Shaw, *op. cit.*, p. 542.
[42]Fisher Scientific Company, *op. cit.*, p. 10.
[43]Shaw, *op. cit.*, p. 540.
[44]Fawcett, "Laboratory Safety," *op. cit.*, p. 1302.
[45]N. E. Viles, *School Fire Drills*, United States Office of Education, Pamphlet No. 103 (Washington: Government Printing Office, 1948), p. 2.

Putting out fires automatically and immediately requires emergency facilities and personnel trained to use them. "The old stand by, water, is hard to beat for fighting fires. A connected hose should be convenient at all times to all parts of the room, including storage cabinets."[46] However, in the chemistry laboratories many fires cannot be put out with water; in some cases, water may even cause the fire to spread. A foam extinguisher should be on hand for oil fires as well as for other combustibles such as rags, paper, and wood. A carbon dioxide extinguisher (since it is a non-conductor of electricity) should be placed near electrical equipment to put out electrical fires. In electrical fires utmost caution should be used to avoid becoming a part of the circuit; the first step in fighting such a fire is to pull the electric switch. Carbon tetrachloride extinguishers are useful for many types of fires, but it must be remembered that carbon tetrachloride produces poisonous phosgene when it becomes very hot.

"There should be at hand at all times in every chemical laboratory, a liberal supply of sand with which to smother small laboratory fires."[47] Fire in the clothing of a fellow worker should always be smothered by use of a fire blanket. This should be a woolen blanket and should be centrally located. One of the best methods of keeping such a blanket in a useable form is to hang it lengthwise from a hook. It should be held to the hook with a light string that can easily be broken by a jerk on the blanket. A shower is sometimes installed in chemistry rooms for the same purpose. It is more difficult to maintain, but has an added value in neutralizing the effects of acids on the clothing or on the body.

Having firefighting equipment available is not sufficient. Students should be thoroughly trained in its use. Demonstrations and practice in the use of fire extinguishers, gas masks, fire blankets, emergency showers, and artificial respiration should be frequent. Realistic experiments, properly safeguarded, on spontaneous combustion and the explosive action of combustibles will do more to guide the future actions of pupils than any amount of preaching about fire, or a diet of *don'ts*. So long as the fire extinguisher remains merely an object fastened to the wall, people will approach it with trepidation and fail to use it effectively.[48]

The removal of pupils from the fire hazard is the only sure means of eliminating fatalities. The fire exit drill is a means of developing proficiency in the removal of the children from the fire hazard. The purpose of the exit drill is to develop and maintain prompt, orderly evacuation procedures. Safety should not be sacrificed for speed.[49] Although pupil evacuation comes first, it is unwise to endanger the building or to create fire hazards that may imperil the children upon their return by leaving possible fire-generating hazards when evac-

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[46]Shaw, *op. cit.*, p. 540.

[47]Central Scientific Company, *op. cit.*, p. 21.

[48]H. H. Fawcett, "Supplementing the Chemical Curriculum with Safety Education," *Journal of Chemical Education*, XXVI (Feb., 1949), p. 108.

[49]New York City Board of Education, *op. cit.*, p. iv.

uating the rooms. Teachers should direct students to shut off any equipment that might create a fire hazard while they are out. Shakers, Bunsen burners, and ovens in the science rooms should be turned off.[50]

Some parents and teachers believe that the money spent on fire-fighting equipment and the time consumed by the firedrills are wasted. This is especially true where there have been no recent local school losses and parents and teachers have become inured to hazards in their buildings. The attitude "it can't happen to us" when applied to laboratory fires indicates a lack of understanding of dangers involved.[51]

THE STUDENT'S RESPONSIBILITY FOR SAFETY

Responsibility to Self and to Others

Safety is an integral part of chemistry and cannot be separated from it. The student should understand that safety is as much a science as chemistry; it is the science of skillful living. Skillful living means not only the ability to use properly that which has been learned, but taking of time and thought to use one's knowledge effectively. Skillful living means skill in the planning of one's body and of every tool, machine, or other object that one uses.[52]

Students must learn to treat chemicals and apparatus at all times with care and respect. Laboratory accidents are usually the result of carelessness or ignorance. A student's carelessness may cause serious injury (cuts, burns, blindness, poisoning, or suffocation) not only to himself but to his classmates as well. Successful laboratory workers never indulge in horseplay or chance taking.[53] No chemical or piece of equipment correctly used will hurt anyone.

The knowledge and skills that prevent accidents in the school laboratory play an important part in making the laboratory a pleasanter place in which to work. The fact that one desires safety for himself and others does not mean that he would hesitate to face danger courageously for a worthy purpose.[54] The pupil must realize the difference between foolish risks, which mean throwing away one's life and one's future usefulness for nothing, and avoidable risks, which may be part of one's job or one's opportunity to serve humanity.[55] Each student needs to learn how to avoid having an accident himself, and each student should also learn how his own acts of commission or omission may have a harmful effect on the others. The proper conduct of preventive activities requires an accurate knowledge of what is to be prevented. The student gains this knowledge of what is to be prevented

[50]Viles, *op. cit.*, p. 3.
[51]*Ibid.*, p. 9.
[52]Herbert J. Stack, Don C. Seaton, and Florence S. Hyde, *Safety in the World Today* (Chicago: Beckley-Cardy Co., 1941), p. xi.
[53]Hercules Powder Company, *Safety Instructions in Chemical Laboratories* (Sixth Edition; Wilmington: Hercules Powder Company, 1939), Chart.
[54]Stack, Seaton, and Hyde, *op. cit.*, p. xi.
[55]Cressman and others, *op. cit.*, p. 14.

only by careful observation of all warnings. These warnings may be expressed by the teachers, found in the directions of the experiment, written on labels of chemicals, placed as signs on equipment, or obtained from conversations with other students.

In recent years, many writers of chemistry laboratory manuals and textbooks have been re-editing their writings so that they include information on accident and health hazards from the use of chemicals and chemical apparatus. However, there are still many books in use that do not include this information. Also, there are still many teachers of chemistry who fail to make safety an integral part of the chemistry course. Many teachers may fail to give sufficient safety instructions through oversight or taking it for granted that the student knows the necessary precautions that should be observed. If safety instructions are omitted by the teacher and the laboratory manual, and the student has some doubt as to the safety involved in an experiment, he should consult the teacher before the experiment is started.

Use of Chemicals and Equipment

Early in the chemistry course students should form certain safety habits that both teachers and authors of laboratory manuals assume that the students will observe after the first few experiments. The following discussion is concerned with some of these safety habits.

Good housekeeping is an essential part of all laboratory operations and must be practiced continually. All spills must be cleaned up at once. Spills on smooth laboratory floors will make them slippery and may cause a serious accident to any person stepping on the spill. "Bench tops should be kept wiped clean. One drop of acid may cause a severe burn."[56] Fires may be started, poisonous fumes generated, or explosive reactions may occur if spills are left for a period of time, or if other chemicals come in contact with them. Keeping equipment clean is an important part of good housekeeping. Whenever a piece of equipment is used, it should be thoroughly cleaned so that it may be used again without further cleaning. Although all equipment should be clean enough to eat out of, a beaker should never be used as a drinking glass and eating in the laboratory should be never permitted.[57]

In connection with good housekeeping, students should always avoid contamination of chemicals. To avoid contamination, one should never pour reagents back into bottles, or exchange stoppers of bottles, or lay a stopper on the table.[58] The student is permitted to pour the contents of a reagent bottle out for his use, but never should a student put anything into a reagent bottle. The reason for this regulation will readily be understood when it is considered that indiscriminate pouring of materials into reagent bottles by students would sooner or later mean sad mixtures and dangerous combinations. In pouring a reagent

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[56]Fisher Scientific Company, *op. cit.*, p. 6.

[57]R. L. Huntington, "The Practice of Safety in the Chemical Engineering Laboratory," *Journal of Chemical Education*, XXV (March, 1948), p. 159.

[58]New York City Board of Education, *op. cit.*, p. 7.

out of a bottle, if too much is removed, one should throw the excess into the waste (slop) jar. The excess should never be returned to the bottle. Students pour reagents only from bottles, never into them. This is a safety measure of prime importance.[59]

The waste jar is a metal or earthenware container that should be provided in every class room where science experiments are performed.[60] For best protection against accidents, separate receptacles for broken glass, acids, and inert chemicals should be provided and should be clearly labeled as to contents and the best place of disposal.[61] Students should use these waste jars only for what they are marked. The jars should never be used for wastepaper baskets. Dry papers may be ignited by a burning match or by chemicals thrown into the jar, and in turn the burning papers may ignite the clothing of the student or cause other fire damage. As an added precaution, a burning or glowing match should never be thrown into the waste jar.

The beginning student will often not know whether a chemical is dangerous; he should, therefore, treat every chemical as if it were dangerous. No chemical from a reagent bottle should ever be tasted. When the student uses a chemical from a reagent bottle, he should check the label carefully to make sure it is the chemical he is to use and to make sure that he has observed all safety precautions. The bottle should always be returned to its proper place.[62] If a student is placing a chemical in a bottle for storage, the container should be clearly marked with the strength of the solution designated.[63] If no other kind of label is available, a piece of adhesive tape will serve the purpose. The following rule should be observed in placing chemicals in containers: "Never fill a receptacle with material other than that called for by the label—and label the container before filling."[64] Students should never remove chemicals from the laboratory room. They should also "never put chemicals in the pockets of clothing of any kind either as joke or for any other reason—otherwise ruined clothing, personal injury, or a general fire may be the result."[65]

There are many other precautions which the student must learn throughout the chemistry course. Whenever a warning is given to the student in regard to a specific act or chemical, he must remember it from then on. The student must remember that safety is a part of chemistry and "that proper methods of mixing acids, cutting glass tubing, and inserting thistle tubes through rubber stoppers are as important as the correct experimental results."[66]

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[59]Howard W. Adams, "Safety Measures in the Chemical Laboratory" (Department of Physical Science, Illinois State Normal University, 1944), p. 4. (Mimeographed)

[60]New York City Board of Education, *op. cit.*, p. 3.

[61]Fisher Scientific Company, *op. cit.*, p. 9.

[62]Shaw, *op. cit.*, p. 542.

[63]Huntington, *op. cit.*, p. 159.

[64]Fisher Scientific Company, *op. cit.*, p. 5.

[65]Central Scientific Company, *op. cit.*, p. 22.

[66]Fisher Scientific Company, *op. cit.*, p. 5.

Wearing of Protective Clothing

Many accidents in the chemistry laboratory could be prevented if the student would wear protective clothing. There are two approaches to the protective-clothing situation. The first is to provide such material in the proper sizes and good quality. The second is the education of the person or persons wearing this equipment.[67]

There are many items available as safeguards against chemical or heat burns. Asbestos gloves, safety tongs, chemical handcreams, rubber gloves, aprons, and goggles are but a few examples. The laboratory should provide these for the student; the absence of them can only be attributed to negligence or false economy.[68] Most high-school chemistry laboratories provide nearly all this equipment; however, it is the usual practice to request students to buy their own aprons. A good quality laboratory apron can be bought for one dollar. Some students believe this cost is too high, but, if they would compare it to the loss of a skirt or a pair of trousers or to personal injury, the cost is small.

The education of the students who are to wear this protective clothing is difficult. When the teacher prescribes protective clothing to be worn while doing an experiment, he will always be confronted by the contention that such clothing is actually unsafe to wear since it sometimes interferes with working convenience. On the surface, this contention sometimes seems to have a well-based foundation. If the student would suppose though that he, through his past, had been going without shoes, it would seem fairly certain that, after putting on his first pair, he would be convinced that he surely would never be able to walk in them, and running would be out of the question. So it is with protective clothing. Gloves can be extreme inconveniences at first, but there are few jobs that cannot be performed while wearing them. Surely a finger, a hand, or even a bad burn is worth much inconvenience.[69]

Rubber gloves, a pair of tongs, a face shield, and a pair of goggles should be kept on hand and used whenever the laboratory directions call for their use. The goggles are intended to protect the eyes from (1) flying glass, (2) sputtering hot or corrosive liquids, (3) fused chemicals such as melted potassium chlorate and sodium nitrate, and (4) molten and flying metals such as sodium and potassium. In case the student habitually wears glasses, such will afford protection for the eyes.[70] Face shields are necessary where the reactions mentioned are more likely to occur or when the accident may be more violent. Tongs, gloves, and mittens are used to prevent burns on the hands, either from handling chemicals or hot equipment. "It should never be

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[67]G. P. Tracey and D. W. Pearce, "Safety in the Laboratory" (Paper Unpublished, presented to the Chemical Education Section of the American Chemical Society; Boston: April 2, 1951), p. 6.

[68]Fisher Scientific Company, *op. cit.*, p. 6.

[69]Tracey and Pearce, *op. cit.*, p. 6.

[70]Adams, *op. cit.*, p. 4.

too much bother to put on gloves or a mitten, or to remove a pair of tongs from a rack when handling hot objects. The careful safety tools become second nature."[71]

Reporting and Treatment of Accidents

Awareness of danger and acquaintance with preventive measures and with the correct way of using an article go far to enable the student to escape an accident and avert an emergency. However, accidents will occur in the chemistry laboratory and the student should be aware of his responsibilities when an accident does occur. The lack of knowledge of an organization of steps to be taken often turns what was perhaps only an insignificant happening into a near fatal mishap.[72]

Students have many accidents in the chemistry laboratory that they consider insignificant and, therefore, do not report. "The student should report every accident and receive first-aid treatment for it no matter how slight."[73] Many chemicals may cause burns or poisoning that are not noticed until sometime after they have had contact with something else and then it is often too late to prevent some damage from occurring. Cuts and burns alike may become infected or irritated by chemicals if not given proper treatment when they occur. Eyes have been lost because students did not receive first aid soon after a chemical had accidentally got into the eye. For these reasons, it should be clear to the student why the immediate reporting of only "minor" injuries is so important.

All injuries should be treated by the chemistry teacher or the school nurse. "In no case shall a student treat his own or a fellow student's injuries, or even remove foreign particles from the eye."[74] In some cases, the teacher may ask the student to assist him in administering first aid; in these cases, the student should give the teacher full cooperation. Many persons, through no fault of their own, become ill at the sight of blood. The student should inform the teacher that he cannot tolerate the sight of blood so that the teacher may choose an assistant who will be able to give more beneficial service.

In each chemistry laboratory there should be a fully stocked first-aid cabinet. The stock in this cabinet should be used only for the treatment of injuries. No student should remove the stock for any other person. Each student should act as a committee of one to promote the proper reporting and treatment of accidents and the proper care of the stocks that are necessary for the treatment.

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[71]Fisher Scientific Company, *op. cit.*, p. 6.

[72]Lyla Olson, *Prevention, First Aid, and Emergency* (Philadelphia: W. B. Saunders Co., 1946), p. ix.

[73]Shaw, *op. cit.*, p. 542.

[74]Michigan State Board of Control for Vocational Education, *op. cit.*, p. 13.

THE TREATMENT OF STUDENTS' INJURIES

Legal Responsibilities

No matter how accident conscious the teacher and students are some accidents will occur. "Any occurence which causes injury to the body, whether visible, alleged, or suspected, should be regarded as an accident and treated as such."[75] First aid should be the only treatment given by the chemistry teacher.

"First aid is emergency treatment only, and involves rendering such assistance as is necessary to place the injured person under competent medical care, with the least possible danger and discomfort to the injured."[76] In the case of an emergency, the teacher is duty bound to render first aid to the best of his ability. "First-aid treatment can be rendered by the teacher without legal responsibility, that is, not subject to suit for damages in the event that one's first-aid efforts prove ineffective or unsatisfactory."[77] "The treatment of any case which is not an emergency is for the pupil's parents to decide. In treating non-emergency cases the teacher may be held legally liable if any further injury results."[78]

The possible danger involved in a teacher treating a non-emergency case is shown in the following example:

> Here the plaintiff was a boy ten years old. The defendants were his school teachers. During an afternoon session of school, defendant No. I, who appears to have been the plaintiff's immediate superior, observed that the little finger on plaintiff's right hand was inflamed. She thereupon asked plaintiff to report at the school office after dismissal for the day.
>
> Plaintiff obeyed, and defendant, according to plaintiff's version, heated a pan of water; then, with the assistance of defendant No. II, another teacher, she immersed plaintiff's hand therein and held it there for about ten minutes. When the plaintiff's hand was withdrawn, the heat had raised blisters. Defendant No. II then escorted plaintiff home in her automobile.
>
> When plaintiff's parents saw his hand they called a doctor, and, on the advice of the latter, plaintiff was taken to a hospital where he remained 28 days. Following this, the plaintiff filed instant action against the defendants asking damages.
>
> Upon the trial there was medical testimony to the effect that the treatment rendered by defendants had aggravated the infection in the plaintiff's finger, and resulted in the permanent disfigurement of his hand. Outcome: a verdict against both defendants for $189.50 for medical and hospital bills, and a verdict against defendant No. I for $1,000.[79]

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[75] *Ibid.*

[76] *Ibid.*

[77] Walter Frank Cobb, *Everyday First Aid* (New York: D. Appleton-Century Co., 1937), p. 5.

[78] Leslie Childs, "What Price Medical Services from Teacher to Pupil," *American School Board Journal,* CX (Feb., 1945), p. 54.

[79] *Ibid.*

In all cases where the injury is serious or the exact character and extent of the injuries are doubtful, the case should be referred to the nearest hospital designated by the board of education, or to the student's own private physician. These are the only agencies authorized to treat school accident cases.[80] In cases where medical treatment is required, the parents should be notified as soon as competent medical aid has been secured. If the student's parents do not want the child sent to the hospital designated by the school board, the school should know this in advance so that the child may receive proper treatment as soon as possible.

Since the teacher has a direct legal responsibility for rendering first aid in the case of a student injury, adequate first-aid training for the teacher is a necessity. In order for the first-aid training of the chemistry teacher to be adequate, the information must be more than that found in the usual first-aid instructions. "It must contain definite directions for the first-aid treatment of the particular accidents, poisonings, and corrosive chemical burns which might occur in laboratories."[81]

General First-Aid Instructions

There are many types of accidents that may occur in the chemistry laboratory and each of these accidents requires a specific type of first-aid treatment. Nevertheless, there are a few initial measures that should be observed in all accidents. The teacher and all the students should know these first-aid measures. "The prime rule—a difficult one to follow—is to keep calm and obtain a clear picture of the accident."[82] If the injured person is unable to move, the surroundings should be observed to see if he is in further danger. If the injury is serious, the teacher should have a person call a physician immediately. All persons not attending the injured persons should be kept away. Generally, two persons are enough to attend a victim. "The person who gives first aid to the injured should be sure that he knows what he is going to do and how he is going to do it. Knowing what to do is important; knowing what not to do is equally important."[83]

Most laboratory accidents fortunately are not too critical. Thev consists chiefly of cuts from the breakage of glassware, and burns from spattering of acids, spillage of hot materials, or from the Bunsen burner. It is important that the teacher know how to treat these minor accidents, and it is also important that he know what to do in case a more critical accident does occur.

Lacerations. Small cuts in themselves are not too dangerous but the possibility of infection is. The first thing to do in the treatment of a small cut is to let the wound bleed for a short while, for the blood

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[80]Michigan State Board of Control for Vocational Education, *op. cit.*, p. 14.

[81]Fisher Scientific Company, *The Fisher Laboratory Emergency Chart* (Pittsburgh: Fisher Scientific Company, 1950).

[82]Fisher Scientific Company, *Manual of Laboratory Safety*, p. 11.

[83]L. G. Derthick, L. E. Sullivan, and J. P. Henderson, *Be Safe and Live* (New York: Johnson Publishing Company, 1940), p. 273.

helps to wash out the germs. If the wound has dirt in it, rubbing alcohol placed in sterile gauze or clean linen should be used to clean it. When the wound is thoroughly clean, it should be dried with gauze. Then merthiolate should be applied and a sterile bandage placed over the cut. This bandage should be changed once or twice a day when the wound is washed. If a swelling, a redness, or a pus formation is noticed after a day or two, the person should lose no time in seeing a doctor, for these are signs of infection.[84]

So long as the laboratory workers insist on trying to force thistle tubes, glass rods, and borers through corks with complete disregard for proper technique, serious lacerations are bound to happen. Deep lacerations of the body at points where pressure cannot be applied directly to arteries or large veins are best controlled by placing a thick padding of sterile gauze directly over the wound. Firm, constant pressure on the gauze is necessary until a clot forms.[85] If the wound is in a position where pressure can be applied to the pressure points to stop the flow of blood, this should be applied by either the fingers or a tourniquet. These points are between the wound and the heart where the supplying artery lies nearest the surface. When using a tourniquet, do not apply any more pressure than is necessary to stop the bleeding. The tourniquet should be loosened for at least one quarter of a minute every fifteen minutes; otherwise, the possibility of blood poisoning is greatly increased. Tourniquets may be made from neckties, rubber tubing, towels, or other such items. The proper use of a tourniquet should be understood by every chemistry teacher.

Burns. Next to lacerations, burns are the most common laboratory injury. For the first-degree burns, determine the cause, if possible, before treatment is begun. Acid burns, except hydrofluoric acid,[86] should be flushed with large quantities of cool water and then with a neutralizing solution of boric acid or neutralizing solution of five percent sodium bicarbonate. If strong alkalis have produced the burn, the burn should be neutralized with a saturated solution of boric acid. After chemical burns have been flushed and neutralized, they can be treated in the same manner as burns from hot objects. The burn should be dressed with sterile gauze covered with butesin picrate ointment, boric ointment, or sterile petroleum jelly and then bandaged securely but not tightly.[87] A second-degree burn, which may occur simultaneously with first-degree burns, is characterized by blistering of the skin. The second-degree burn should be treated in the same manner as just described. The blisters of a second-degree burn should not be opened without the specific instructions from a physician. Third-degree burns cause complete destruction of the entire skin thickness. They are, of course, the most serious type of burn both from the

[84]*Ibid.*, pp. 274-5.

[85]Fisher Scientific Company, *Manual of Laboratory Safety*, p. 12.

[86]For proper treatment of hydrofluoric acid burns see "Treatment of Poisons."

[87]Fisher Scientific Company, *Manual of Laboratory Safety*, p. 12.

standpoint of shock and of the possibility of infection. It is best to leave the third-degree burns to a physician. If the victim goes into shock from the burn, this should be treated first.

Shock. Shock is caused not only by severe burns but may be caused by any injury. Sometimes the sight of a wound or of blood will cause a person to go into shock. Shock may be defined as the failure of blood vessels throughout the body to function. Subjective symptoms complained of by patients in early acute shock consist of a feeling of marked weakness, faintness, sometimes dizziness and often nausea. The patient's general appearance is typical and of great diagnostic value. The skin is first pale and then becomes an ashen color. It is cold and becomes clammy from perspiration. The pupils are dilated and the eyes have a glassy look, or a vacant stare.[88]

Immediate first-aid treatment is necessary in shock cases. The patient should first be placed in a reclining position with his head lower than his body and then wrapped up in blankets, under which heated objects should be placed. Care should be taken not to increase the heat of the body too fast for this will increase the shock. If the person is conscious, liquid stimulants such as hot coffee, tea, water, broth, or milk may be given. Liquids should never be placed down the throat of the patient who is unconscious, as this is a very easy way to drown him. If the patient is unconscious, stimulants may be given by inhalation. Vapors which act as good stimulants are grain alcohol, acetic acid, diluted ammonia, smelling salts, or amyl nitrate. No stimulant should be given a patient before it is first tested.[89]

Eye Injuries. Injuries to the eye from chemicals are very common in the laboratory and should receive special consideration. The irrigation of the eye is of first importance in this type of injury. This irrigation may be accomplished by holding the eyes open over a bubbler fountain, dipping the hand into a sink or bucket of clean water, or lying flat on the back and having a moderate stream of water directed into the eyes from a rubber tubing. If the chemical is either acid or alkali, it must be neutralized after the irrigation. If the chemical is an acid, the lid should be held open and the eyeball irrigated with a five percent solution of sodium bicarbonate. If the chemical agent is an alkali, the eye should be washed with a one percent solution of zinc sulfate solution or a two percent acetic acid solution. Each of these must be followed by a plain water wash.[90] A few drops of olive oil or mineral oil may then be put into the eye and the eye covered with a dressing. The patient should then be sent to a physician for more complete treatment and examination.[91]

Poisons. Laboratory workers are seldom guilty of accidental swallowing of virulent solutions or of transferring to the mouth poison

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[88]Warren H. Cole and Charles B. Prestow, *First Aid, Surgical and Medical* (New York: D. Appleton-Century Co., 1942), p. 89.

[89]Fisher Scientific Company, "The Fisher Laboratory Emergency Chart."

[90]Adams, *op. cit.*, p. 3.

[91]Cole and Prestow, *op. cit.*, p. 127.

which may adhere to the skin. When such an accident does occur, or when poisons are in contact with broken skin, prompt administration of the proper antidote is often the only action that will prevent serious consequences. Antidotes for specific types of poisonings are listed at the close of this publication under "Treatment of Poisons." If the cause of poisoning is not known or an antidote is not given, one should proceed at once to induce repeated vomiting by administering powdered mustard in a thin paste of warm water, warm salt water, or soap suds. The emetic should be followed with a heaping teaspoonful of universal antidote in two parts pulverized charcoal, one part magnesium oxide, and one part tannic acid. It should be kept dry and ready for use in the laboratory first-aid cabinet.[92]

Toxicity. Toxic fumes are always a danger in the chemistry laboratory. Many toxic fumes are distinguished by heavy offensive odors, but some have hardly any odor at all. The first symptom of a person affected by toxic fumes is a headache, and other symptoms that follow are dizziness, nausea, and drowsiness. If a student complains of a headache, this should serve as a warning to the teacher and he should immediately take steps to clear the laboratory of all possible toxic fumes.

Aspirin and a half hour of rest and quiet will usually relieve a toxic headache. If a student is overcome by toxic fumes, he should be removed at once to the open air, all tight clothing removed, and artificial respiration given.

Toxicity is not the only case in which artificial respiration may be employed. This aid is also a necessity for a person who is unconscious from electrical shock. The teacher should, therefore, thoroughly understand the method of giving artificial respiration. In nearly every class there will be a Boy Scout who knows how to administer artificial respiration, and the teacher would be wise to assign this task to such a person. This would leave the teacher free to carry out first-aid treatment that might be needed.

First-Aid Cabinets

Just as special first-aid training is necessary for the chemistry teacher, special materials are needed to render first aid. It is obvious that an ordinary household or industrial first-aid kit is not suitable to meet the special emergencies that may arise in the laboratory. These special materials should be obtained and stored in cabinets or boxes used exclusively as containers of first-aid materials. These containers should be dust proof, should be kept clean, and should be completely supplied with approved materials at all times.[93]

The majority of the materials needed in the first-aid cabinets can be obtained from a local drug store or made up in the laboratory. First-aid cabinets completely stocked can be obtained from most chemical supply companies. Whether the teacher stocks his own cabinet or orders

[92]Fisher Sientific Company, *Manual of Laboratory Safety*, p. 13.
[93]Michigan State Board of Control for Vocational Education, *op. cit.*, p. 18.

a completely stocked one, he should make sure that it contains the following materials:

1 only	eye cup
1 pair	scissors
1 pair	tweezers
1 only	tourniquet
1 only	stainless steel teaspoon
1 package	paper cups
1 roll	adhesive tape ½"
2 rolls	gauze bandage 1"
1 roll	gauze bandage 3"
2 dozen	band-aids
½ ounce	cotton
1 dozen	wood applicators
½ dozen	amyl nitrate capsules
4 ounces	aromatic spirits of ammonia
3 ounces	boric acid powder
1 tube	boric acid ointment
1 bottle	aspirin
1 tube	butesin picrate ointment
2 ounces	castor oil
1 ounce	copper sulfate
2 ounces	egg albumin
1 ounce	merthiolate
1 ounce	magnesium sulfate powder
6 ounces	milk of magnesia
4 ounces	mineral oil
2 ounces	mustard, powdered
1 tube	petroleum jelly
4 ounces	sodium bicarbonate
4 ounces	sodium hydrogen phosphate
1 ounce	sodium sulfate
2 ounces	sodium thiosulfate
1 ounce	soluble starch
1 ounce	tannic acid
2 ounces	universal antidote
4 ounces	5% acetic acid solution
4 ounces	1% boric acid solution
2 ounces	2% boric acid solution
4 ounces	1% copper sulfate solution
4 ounces	ethyl alcohol (100 proof)
4 ounces	3% hydrogen peroxide
4 ounces	10 % magnesium sulfate solution
4 ounces	5% sodium bicarbonate solution
4 ounces	10% sodium acid phosphate solution
4 ounces	1% zinc sulfate solution

These materials should be kept in separate closed containers and each item should be labeled to show content and proper use. First-aid

cabinets should never be locked to prevent the removal of materials for uses other than treating the injured; instead, the teacher must impress upon the student the proper attitude toward these materials. To insure himself that all supplies are always on hand in the first-aid cabinet, the teacher should adopt a regular time for checking the contents. To facilitate this checking, he should make out a form which lists all items that belong in the cabinet. Each time the cabinet is checked this form should be dated and initialed by the checker. As each item is checked a special mark may be made if it is there and another if the item is missing. All missing items should be replaced as soon as possible.

A chart containing first-aid procedure should be placed near the first-aid cabinet, preferably on the door. The different directions covering emergency treatment should be arranged alphabetically so that they can be referred to quickly and comprehended in the minimum amount of time. The advantage of having the first-aid cabinet full of material and the procedure chart together is easily seen. A check of supplies to be used before the first aid is begun saves the regrettable occurrence of improper treatment.[94] Along with this chart a number of other emergency aids should be listed. The names and telephone numbers of at least two doctors, the name and telephone number of a hospital, and the telephone number of the fire department should all be listed. The location of other first-aid materials such as blankets, stretcher, hot water bottles, and gas mask should also be listed.

Accident Report Sheets

Information on the unsafe acts and unsafe conditions causing accidents and injuries to students is essential to the planning of an efficient chemistry safety program.[95] The only way of obtaining such information and of keeping it for future use is to have an efficient accident reporting system. This requires that a written report of every accident, no matter how minor it is, be made as soon as possible after it occurs. "Even a minor accident is an indication of mechanical or human failure and should be studied with a view of remedying the conditions which might cause its recurrence with perhaps more serious consequences."[96]

If the faculty and students understand the values to be derived from an accident reporting system, they will cooperate more fully in reporting accidents. The primary purpose of such reports should be to discover and eliminate accident causes. Therefore, the report should disclose hazards in the use of equipment and specific chemicals that need to be eliminated. Liability is another reason why chemistry

[94]Fisher Scientific Company, *Manual of Laboratory Safety*, p. 21.
[95]National Standard Student Accident Report Committee, "Keeping Student Accident Records," *Safety Education*, XXVII (Sept., 1947), p. 13.
[96]Cressman and others, *op. cit.*, p. 25.

teachers should make complete reports on injuries to students. The facts collected may be invaluable in case of a law suit. A third reason for making accident reports is that they tend to stimulate interest and cooperation of the teachers and students in the safety program. The student's accident report may be used for guidance and should be included in the student's cumulative record. Such records indicate points for emphasis in the laboratory safety program and may serve as one means of evaluating the effectiveness of the program. [97]

[97]American Association of Teachers Colleges and National Commission on Safety Education, *op. cit.*, p. 50.

Useful Publications for High-School Teachers of Chemistry

Chemicals. Safety Education Data Sheet No. 14. National Safety Council, 425 N. Michigan Street, Chicago 11, Illinois. 4pp. Reprint 7 cents. This data sheet discusses the type of injuries that are caused by accidents, proper treatment in case of accident, and methods of preventing accidents. It is directed to both home and school activities.

Cooking and Illuminating Gas. Safety Education Data Sheet No. 20. National Safety Council, 425 N. Michigan, Chicago 11, Illinois. 4 pp. Reprint 7 cents.

This sheet is not directly concerned with the laboratory but does contain some useful information on the hazards of gases, the safe use of gases, and measures to use in case of an emergency.

First-Aid Suggestions. Employers Mutual Liability Insurance Company of Wisconsin, Wausau, Wisconsin. 6 pp. Gratis.

Only general first aid is discussed in this pamphlet; however, it is worthwhile if only for its discussion of bleeding.

For Greater Safety in Science Teaching. New York City Board of Education, New York City. 27 pp. 1949. Gratis.

This source contains safety suggestions for all high-school science courses. The sections related to chemistry deal with matters which are deemed hazardous, proper means of storing chemicals, and laboratory techniques and procedures.

Industrial Safety Education in Schools. Metropolitan Life Insurance Company, New York City, New York. 48 pp. 1949. Gratis.

Although this booklet is primarily designed for use in industrial arts, much of the material can also be applied directly to chemistry.

Laboratory and Demonstration Equipment for Secondary-School Chemistry and Precautions to be Observed in the Handling and Use of Chemicals. Central Scientific Company, 1700 Irving Park Road, Chicago 13, Illinois. 25 pp. 1948. Gratis.

As the title suggests this is primarily a catalog for equipment. However, three pages are devoted to precautions to be observed in the use of chemicals by students and teachers.

Laboratory Emergency Chart. Fisher Scientific Company, 717 Forbes Street, Pittsburgh 19, Pennsylvania. 1950. Gratis.

This is a handy reference chart showing emergency treatment for various accidents that may occur in the laboratory. It is an ideal chart for hanging near the first-aid cabient.

Laboratory Glassware. Safety Education Data Sheet No. 23. National Safety Council, 425 N. Michigan Street, Chicago 11, Illinois. 4 pp. Reprint 7 cents.

The safe use of glassware in the laboratory is explained with the aid of some drawings. This data sheet is particularly helpful for students.

Manual of Laboratory Safety. Fisher Scientific Company, 717 Forbes Street, Pittsburgh 19, Pennsylvania, 39 pp. 1949. Gratis.

This booklet is written from the standpoint of industrial laboratories, but nevertheless contains material useful in the high-school chemistry laboratories. It contains materials on accident prevention, first aid, fire prevention, and safety equipment.

Safety Education for Teachers. National Education Association, 1201 16th Street, N. W., Washington, D. C. 62 pp. 1946. Single copy 30 cents.

This is a guide for administrators in teachers colleges and in schools of education. However, it contains some general information useful to the teacher in service.

Safety Instruction in Chemical Laboratories. Hercules Powder Company, Wilmington 99, Delaware. 1939. Gratis.

This is a chart printed on both sides. One side is for the use of the teacher and the other side is for the use of the students. It contains material on how to store chemicals, how to fight fires, what techniques to follow in the use of chemicals and equipment, and what to do in case of an accident.

School Fire Drills. N. E. Viles, Pamphlet No. 103. United States Office of Education, U. S. Government Printing Office, Washington 25, D. C. 19 pp. 1948. Copy 10 cents.

This pamphlet discusses fire drills in all areas of the school. It contains only general information useful to the chemistry teacher.

Movies and Film Slides

First Steps in First Aid. United States Bureau of Mines, Experiment Station Graphic Service Section, 4800 Forbes Street, Pittsburgh 13, Pennsylvania. Loaned free. 16mm. Sound motion picture. 31 minutes.

This is a very good film for senior-high school students; it explains such things as the treatment of shock, cuts, and burns. The danger of wound infection is emphasized throughout the movie.

Laboratory Glassware. National Safety Council, 425 N. Michigan Ave., Chicago 11, Illinois. Cost unknown. 35 mm. Slide.

These slides show how to avoid hazards likely to cause painful cuts or serious injuries. Suitable for both industrial laboratory workers and high-school students. An instructor's manual is also available.

Safety in the Chemistry Laboratory. Indiana University, Audio-Visual Center, Bloomington, Indiana. Rent $2.75. 16 mm. Sound motion picture. 20 minutes.

Professional chemists are shown using safe practices. The basic safety rules which should be practiced by high-school students are presented. The wise use of protective clothing, the proper labeling of bottles, and the use of fume hoods are also shown.

Safety in the Laboratory. Visual Sciences, Box 599 - H. W., Suffern, New York. With text $3.00. 53 Frame slides.

These slides illustrate the basic practices which make for safety in the school laboratory.

Treatment of Poisons

This list shows the poisonous chemicals that are required for use with twelve commonly used high-school chemistry manuals (workbooks). The treatments for these poisons are those recommended by Fisher Scientific Company on their Laboratory Emergency Chart.

Acetone—

Induce vomiting with emetics such as mustard, magnesia, chalk, soap, or oils. Administer universal antidote and keep patient awake.

Acid, Carbolic—

Immediately administer four ounces of ethyl alcohol in four ounces of water and then induce vomiting. Administer milk, white of an egg, or mineral oil.

Acid, Hydrofluoric—

When it comes in contact with the skin, the area should be washed immediately with cold running water and large amounts of sodium bicarbonate. This should be continued until the area becomes red. After this, apply a freshly prepared 20% suspension of magnesium oxide in glycerol or cover with sterile boric acid powder and then a wet compress saturated with boric acid solution.

Acids, Mineral—

Do not induce vomiting. Give milk of magnesia immediately and repeat the dose at short intervals. Do not give carbonates. Administer milk, white of an egg, or egg albumin in cold water until the acid appears to be neutralized and then administer mineral oil.

Alcohols, Amyl and Methyl—

Induce vomiting. Administer milk, white of an egg, or egg albumin and then give a large pinch of sodium bicarbonate. Be sure the patient gets plently of fresh air.

Iodine and Iodine Solutions—

Administer a thin paste of soluble starch solution and then induce vomiting.

Lead and Lead Compounds—

Induce vomiting and then give 10% magnesium sulfate solution followed by milk, white of an egg, or egg albumin in cold water.

Mercury and Mercury Compounds—

Induce vomiting. Administer milk, white of an egg, or egg albumin followed by a teaspoonful of sodium thiosulfate in a half pint of water.

Phosphorous and Phosphorous Compounds—

Induce vomiting, then administer one-half teaspoonful of copper sulfate, followed by large amounts of water, and finally a 10% solution of magnesium sulfate.

Potassium Permanganate—

Induce vomiting and then give milk, white of an egg, or egg albumin. Follow this with 5 cc of 3% hydrogen peroxide in a half glass of water made slightly acid with acetic acid.

Silver Nitrate—

Induce vomiting with salt water and continue until stomach is completely flushed. Then administer milk, white of an egg, or egg albumin.

Tin Compound—

Induce vomiting and then give milk of magnesia or mineral oil.

Zinc Compounds—

Induce vomiting and then give large quantities of 5% sodium bicarbonate solution followed by milk, white of an egg, or egg albumin in cold water.

Storing Common Hazardous Chemicals

Bromine—

The usual shipping container is a glass bottle. In storing, the bottles should be surrounded by incombustible packing and isolated so that in case of breaking it will not come in contact with organic material.

Hydrofluoric Acid—

Aqueous solutions should be stored in wax bottles placed inside metal containers. These containers should be placed in a well ventilated place.

Magnesium—

Magnesium ribbon should be stored away from moisture and oxidizing materials. If magnesium is powder or in shavings it should be placed in a tightly closed metal container.

Phosphorous, White (or Yellow)—

Phosphorous should be isolated from other chemicals. It should be stored under water in hermetically sealed cans.

Sodium—

Do not store sodium near phosphorous. Do not tier it if it can be avoided. Keep sodium starch under kerosene in a sealed container. Keep it away from all water and avoid sprinkler systems.

Sodium Peroxide—

Keep stored in tightly closed metal containers. Store remote from organic substances and water; do not expose to sprinkler systems.

Activities of the University Faculty

Dr. Emma Knudson, director of the division of music education, was asked by the National President, Marguerite V. Hood, to serve on a committee representing the Music Educators' National Conference at the annual meeting of the National Association of Schools of Music in Cincinnati, Ohio, on November 22, 23, and 24. Three sessions were devoted to discussion of ways in which the curricula can be improved in the several hundred schools offering courses in music education. Dr. Knudson was invited to serve on the jury for the Music Research Project initiated by the steering committee of the Illinois Secondary School Curriculum Program. She attended meetings of the jury on January 12 and February 16.

Helen Chiles, assistant professor of Latin, attended the meeting of the Illinois Classical Conference at Alton on February 21, 22, and 23, where she gave a paper on "Magic and the Supernatural in Seneca's Tragedies."

G. Bradford Barber, assistant professor of speech, participated in a panel discussion during the convention of the Speech Association of America in Chicago on December 28. The topic discussed was "What kind of forensic program should the modern high school have?"

Elsie Brenneman, director of admissions, is on the Executive Board of the Association of College Admissions Counselors. She has been asked to appear on a panel on the program of the annual meeting of the National Association of Collegiate Registrars and Admissions Officers, to be held in Washington, D.C., in April. For this same national organization, Miss Brenneman is serving on a committee that is working on "High School-College Relations."

Zora Cernich, assistant professor of health and physical education, attended a Christmas Folk Dance School at Berea College, Kentucky, from December 26 to January 6. Every Wednesday and Thursday evening, she conducts square-dance classes at the Clinton, Illinois, Young Men's Christian Association.

Malinda D. Garton, instructor and supervising teacher for the mentally retarded, talked to the Future Teachers of America at Normal Community High School on "Opportunities in Special Education," January 3. In December she was on a panel at the same school for the Parent-Teacher Association, discussing curriculum problems.

Perry Hackett, instructor in music, with the other members of the faculty trio, Mr. Herbert Sanders and Miss Isabelle Terrill, gave a radio program over WJBC on December 7. Mr. Hackett played a solo over the same station on January 10.

Dr. Miriam Gray, associate professor of health and physical education, wrote the leading article, "Windows to Physical Education," in the revised edition of the pamphlet, *Special Events in the Physical-Education Program,* edited and published by the National Section on Women's Athletics in January. This section is a part of the American Association for Health, Physical Education, and Recreation. Dr. Gray was appointed chairman of the program committee for the meeting of the Illinois chapters of the American Association of University Professors, to be held on the Illinois Wesleyan University campus March 22.

Dr. Gertrude M. Hall, director of publicity, wrote "Cooperation for Teacher Education Among State Colleges and Universities" in the January number of *College Public Relations Quarterly,* published by the American College Public Relations Association. This article is a

summary of her doctoral project completed last summer. She attended meetings of the American Association of Colleges for Teacher Education in Chicago, February 20-23, as a member of the organization's public relations committee. Dr. Hall talked at a meeting of the Joint Alumni Council in Chicago on December 27.

Dorothy Hinman, assistant professor of English, gave a talk on December 5 at the Bellflower Mid-Century Club on "New Books for Children."

Dr. F. Lincoln D. Holmes, director of the division of speech education, attended the annual conferences of the Speech Association of America and the American Speech and Hearing Association in Chicago, December 27, 28, and 29.

Dr. C. A. DeYoung, professor of education, has delivered numerous talks on his round-the-world trip, including addresses at Forrest, Decatur, Lincoln, Gridley, Hudson, Springfield, Ottawa, Morris, and St. Louis. He also attended a meeting of the committee on International Aspects of the American Association of Colleges for Teacher Education in Washington, D.C. Dr. DeYoung wrote an article entitled "This World" in the December issue of *Educational Leadership*. Dr. DeYoung presided, February 1, at the mid-year meeting of the Illinois Association of School Masters, of which he is president. He also presided at the annual meeting of the overseas educational consultants in St. Louis.

Josephine B. Howard, instructor and supervising teacher in the first and second grades in the special-education building, was chairman of the radio program on WJBC regarding the Special Education Department on December 13.

Leslie Isted, associate professor of music, wrote "Visible Music: Part III" in the January-February issue of the *Illinois Music Educator*, published by the Illinois Music Education Association.

Dr. Bernice Cooper, professor of health and physical education, has been reappointed to the Educational Policies Committee of the Midwest Association of College Teachers of Physical Education for Women. She was formerly a member and also chairman of this committee.

Dr. Helen E. Marshall, professor of social science, attended the meeting of the American Historical Association in New York City on December 28, 29, and 30.

Dorothy M. McEvoy, instructor and supervising teacher of the deaf and hard of hearing, served December 12 on the radio committee of the Special Education Building. This committee gave an original skit over station WJBC. This skit was written and presented by faculty members—Josephine Howard, Lowell Kuntz, and Dorothy McEvoy. It explains the program carried on at the Special Education Building with children in the building taking speaking parts. A recording was made of this broadcast and cuttings of it are available on loan.

Dr. C. E. Horton, director of the division of health and physical education, on January 8 met with representatives of teachers colleges to draw up a statement of policy in athletics for the teachers colleges of Illinois. On January 12, he attended an executive committee meeting of the Illinois Physical Education Association in Chicago to plan the state meeting for April. On January 14, Dr. Horton spoke before the McLean County Teachers on "Physical Education and Athletics in McLean County Schools," and on January 23 before the Normal Optimist's Club on "Camping for the Handicapped."

Dr. Vernon L. Replogle, principal of Metcalf Elementary School, was a resource person in the discussion section, "Design for Curriculum Change," at the

Association for Supervision and Curriculum Development Conference in Boston on February 10-14.

Dr. Stanley K. Norton, assistant dean of men, talked on January 17 at the annual meeting at the Streeter Memorial Congregational Church, Thawville, Illinois, on the subject, "Church and State."

Alice R. Ogle, assistant professor of art, had an article published, entitled, "Art Is For All Children," in the *Junior Arts and Activities* for January.

Dr. Florence E. Teager, professor of English, spoke before the Woman's Club at Atlanta on March 19 on the subject, "Problems of the British Schools Today."

Leslie D. Park, instructor and supervising teacher of health and physical education, recently gave a speech entitled "Boys are My Business" before the Central Illinois Dale Carnegie Club dinner. Mr. Park is chairman of the Public Relations committee of the Illinois Association for Health, Physical Education, and Recreation.

Dr. Rose E. Parker, director of the division of special education, has been appointed to the Governor's Commission for Handicapped Children for a period of three years, beginning August 1, 1951.

Cecilia Peikert, director of museums, wrote an article on "Sing a Song of Christmas" in the December *School Arts Magazine*.

Dr. H. W. Peithman, associate professor of music, directed the Men's Glee Club in a program for the Illinois School Masters' Club on February 1 at the Wesleyan Memorial Center.

Dr. Nina Gray, professor of biological science, attended the annual meeting of the American Association for the Advancement of Science and the thirtieth anniversary celebration of Sigma Delta Epsilon (graduate women's scientific fraternity, of which she was national secretary for four years, from 1939 to 1943, and national president in 1946) in Philadelphia, Pennsylvania, December 26-31.

Eunice H. Speer, assistant professor and assistant librarian, reviewed McCracken's "The Flaming Bear" for the *Library Journal* for December 15.

Dr. Glenn Taylor, professor of speech, attended the annual convention of the American Speech and Hearing Association.

D. F. Templeton, instructor in the teaching of English, has been named to the planning council of the Illinois State High School Press Association by Ralph Blackman, president of the Illinois Association of Teachers of Journalism.

Edna E. Engberg, instructor in health and physical education, wrote a brief description of the physical-education program for exceptional children in the Special-Education School for the *Illinois Physical Education News* for December.

Dr. Dorothy Fensholt, assistant professor of biological science, gave a talk before the Sigma Xi Club of Bloomington-Normal on "Research Opportunities at Marine Biological Laboratories" on December 13.

Inez L. Mauck, supervising teacher in the fourth grade, was a consultant in Language Arts at a recent curriculum meeting in Eureka.

Waneta S. Catey, principal of the Special-Education School, talked to a young women's group on January 9 in Minier, Illinois, on "Problems of Young Children." On January 18, Mrs. Catey attended a committee meeting in Springfield to help plan a workshop for chapter officers attending the annual convention of the International Council for Exceptional Children at Omaha.

Doris Hardine, instructor and supervising teacher in instrumental music, and Wilma M. Schell, instructor in music, have given a series of programs

together. They gave a thirty-minute program at Cerro Gordo, Illinois, on December 3, for the Band Mothers' Association; a fifteen-minute program for the Methodist Church in Normal following a family church night supper on January 23; and a radio broadcast over WJBC on February 7.

Ella C. Leppert, assistant professor of the teaching of social science, was a consultant at a workshop in Pere Marquette, December 3-6, for the Illinois Secondary School Curriculum Program (Citizenship Educational Project). Miss Leppert was also a consultant at Paxton on Curriculum Improvement on January 9.

Dr. Christine Ingram, professor of education, attended the fourth International Congress of Mental Health held December 15-19 in Mexico City. This congress was conducted for psychiatrists, psychologists, social workers, and educators from thirty countries. She participated in a working group that discussed "Mental Health of the Retarded." Ronald Press has accepted the manuscripts of Dr. Ingram's revision of her text *Education of the Slow-Learning Child*. She attended a dinner meeting of the Board of Directors of the Peoria Mental Hygiene Society, February 13, to report on the meetings of the International Congress for Mental Health held in Mexico City.

Irwin Spector, associate professor of music, had an article published in *Symphony* for November entitled "Gaspard Duiffoprougcart, an Early Violin Maker."

Dr. Dale Vetter, associate professor of English, wrote an article entitled "William Walsh's 'In Defense of Painting'" for the *Modern Language Notes* for December.

Dr. L. R. Toll, director of the division of business education, served as liaison officer for the social-business round table, and the college department round table at the convention of the National Business Teachers Association December 27-30 at Chicago. Dr. Toll met with the other board members of the National Business Teachers Association in Chicago, January 18-19, to plan the activities for the year. On February 8-9, he met with representatives of the other teacher-training institutions and the members of the Business Education Service of the State Board for Vocational Education to make plans for in-service teacher training. On February 21, he gave a talk at the meeting of the Administrators' Division of the United Business Education Association in Chicago on the administrative problems of the business-education departments of the teacher-training colleges.

Dr. F. Louis Hoover, director of the division of art education, was a luncheon speaker on February 23, at the National Art Education Association meeting in St. Louis. The title of his talk was "The Art Teacher in Your School."

Dr. Ralph A. Micken, associate professor of speech, spoke at the national convention of the Speech Association of America in Chicago on December 28 on the topic "Debate and/or Discussion." Dr. Micken also spoke on "The Adult Speech Course" at the Young Men's Christian Association Board Meeting at Clinton on January 10.

Elizabeth Russell, assistant professor of education, participated in a study group at the national meeting of the Association of Supervisors and Curriculum Development in Boston, February 9-15. She attended the national meeting of Supervisors of Student Teaching in Chicago, February 22 and 23.

Dr. Marguerite R. Connell, associate professor of foreign languages, attended the annual meeting of the Illinois Classical Conference held in Alton, Illinois, February 21-23. She is a member of the Executive Council of the Conference.